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Suganuma et al.

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(54) **FIXING DEVICE AND IMAGE FORMING APPARATUS INCORPORATING SAME**

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G03G 15/20 (2006.01)
G03G 15/23 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/2039*** (2013.01); ***G03G 15/2042*** (2013.01); ***G03G 15/231*** (2013.01); *G03G 15/2082* (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/2039; G03G 15/2042; G03G 15/2078; G03G 15/202
USPC 399/67, 69, 334
See application file for complete search history.

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(57) **ABSTRACT**

An image forming apparatus includes a fixing member, a pressing member, heat generators, temperature detectors, a power source, and a heat controller. The heat generators include a first heat generator and second heat generators corresponding to an imaged area and a blank area, respectively, of a recording medium. The heat controller controls a power source according to data provided by the temperature detectors, such that a heating area of the fixing member heated by one of the second heat generators located adjacent to the first heat generator acquires a temperature of T**1**−ΔT, where T**1** is a temperature corresponding to the imaged area higher than a temperature T**2** corresponding to the blank area, and ΔT is a temperature lower than a difference between T**1** and T**2**. The heat controller changes ΔT between when a first side thereof is printed upon duplex printing and upon single-sided printing.

11 Claims, 7 Drawing Sheets

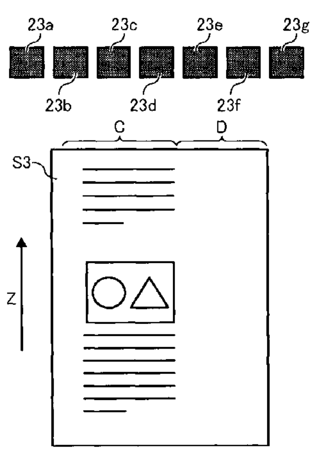
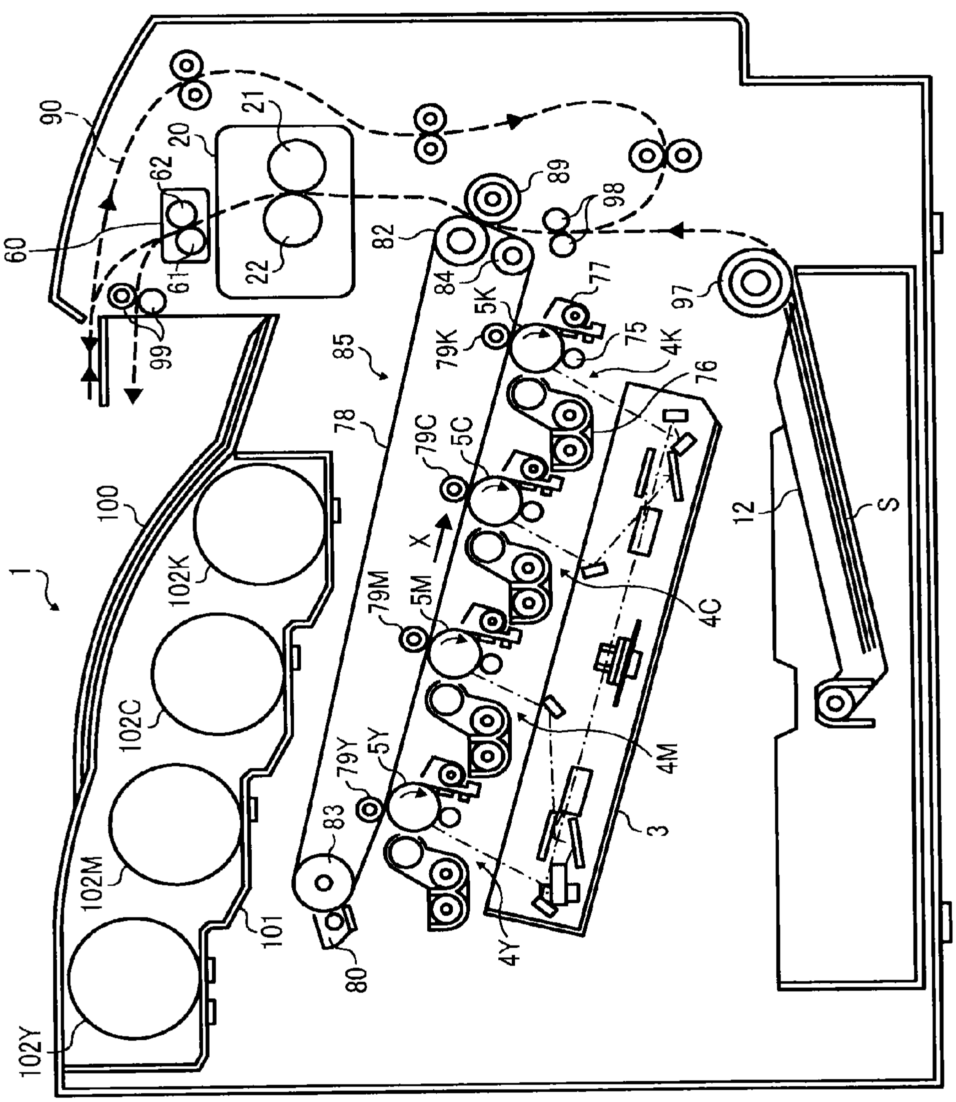


FIG. 1


1
90
20
21
22
60
62
61
99
89
98
82
84
77
5K
79K
75
4K
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97
85
78
79C
5C
X
100
102K
79M
5M
4C
12
S
102C
4M
79Y
5Y
83
102M
101
3
80
4Y
102Y

FIG. 2

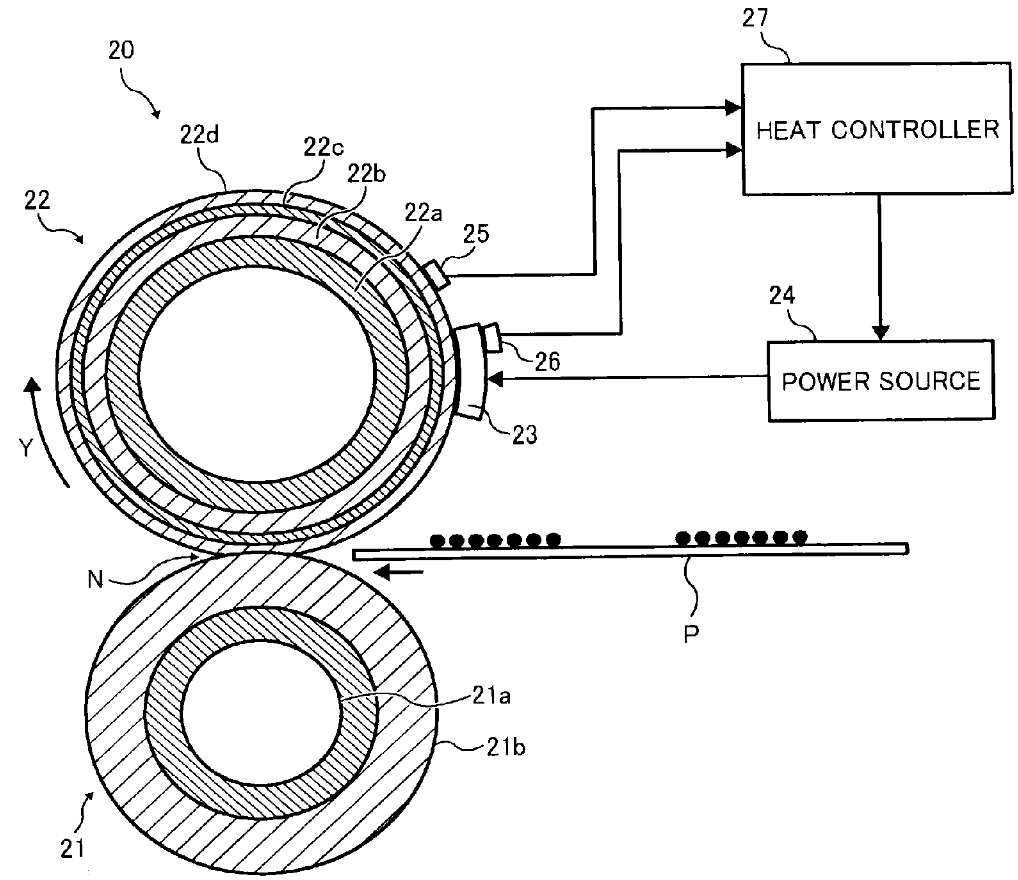
27
HEAT CONTROLLER
20
22d
22c
22b
22
22a
25
24
26
POWER SOURCE
23
Y
N
P
21a
21b
21

FIG. 3

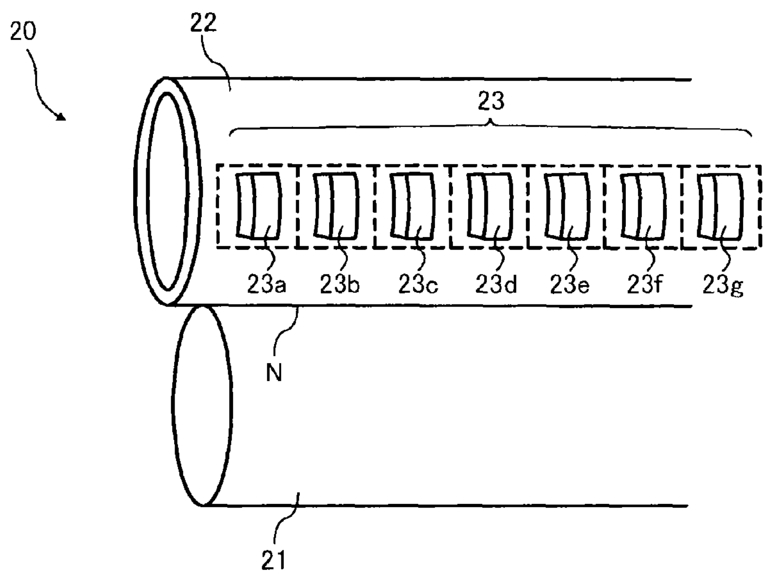

FIG. 4A

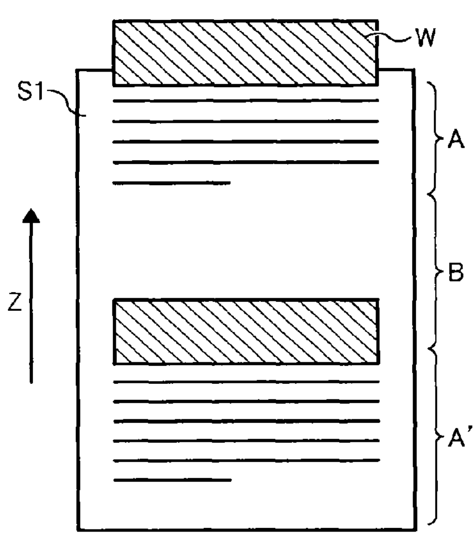

FIG. 4B

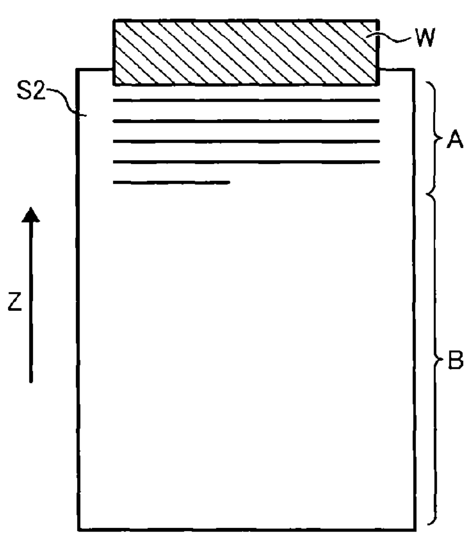

FIG. 5A

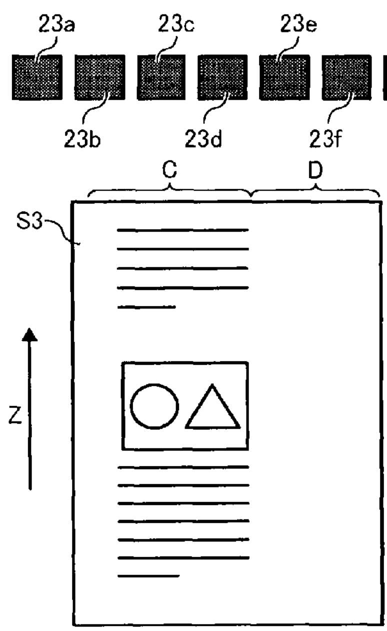

FIG. 5B

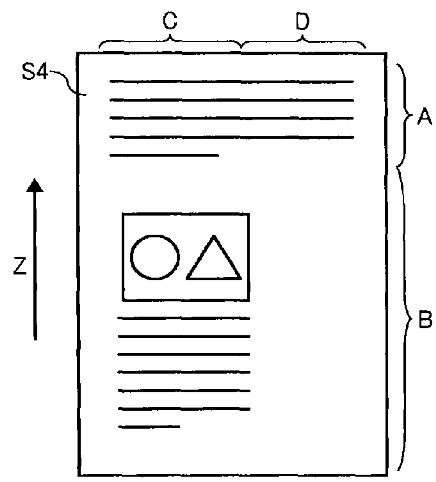

FIG. 6

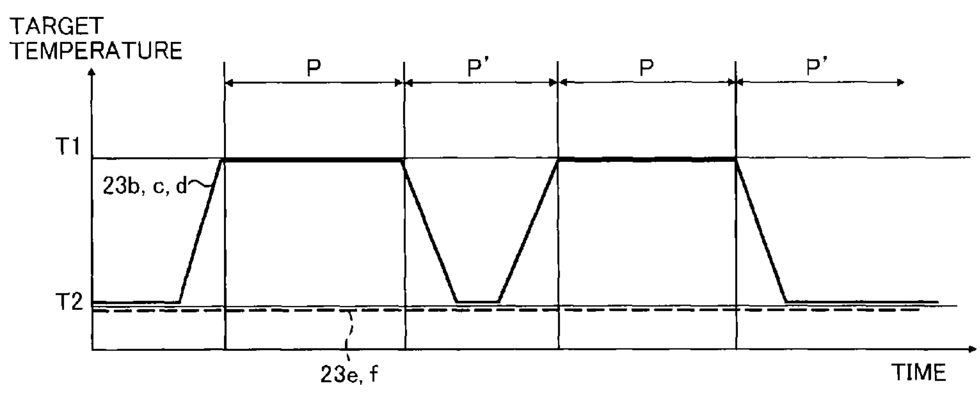

FIG. 7

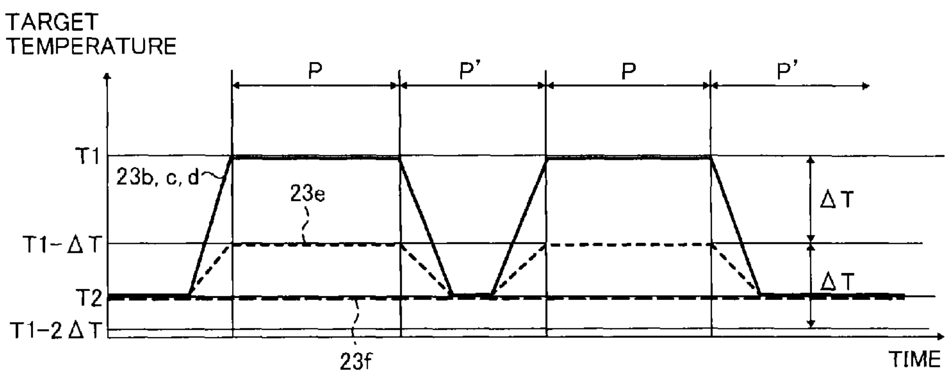
TARGET TEMPERATURE
P
P'
P
P'
T1
23b, c, d
23e
ΔT
T1−ΔT
T2
ΔT
T1−2ΔT
23f
TIME

FIG. 8

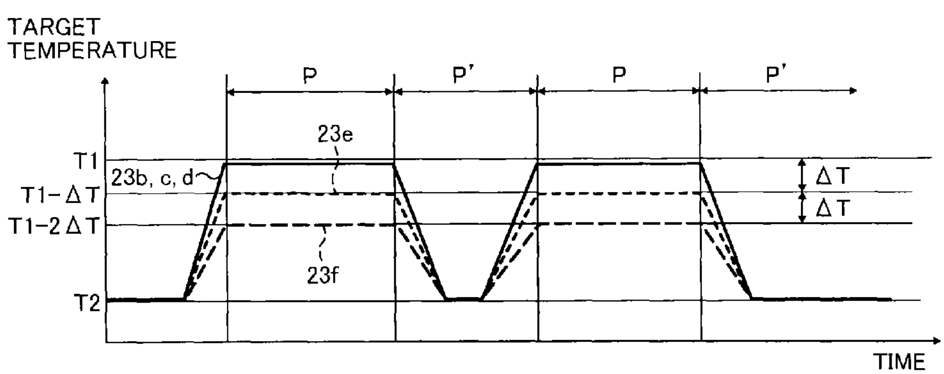
TARGET TEMPERATURE
P
P'
P
P'
23e
T1
23b, c, d
ΔT
T1−ΔT
ΔT
T1−2ΔT
23f
T2
TIME

FIG. 9

	PAPER TYPE NOT SPECIFIED	RECYCLED PAPER	COATED PAPER	ENVELOPE	OHP
THIN PAPER (52-59gsm)	10	7	–	–	–
PLAIN PAPER (60-81gsm)	18	15	–	–	–
MEDIUM THICK PAPER (82-105gsm)	30	22	–	2	–
THICK PAPER 1 (106-169gsm)	40	30	40	2	–
THICK PAPER 2 (167-210gsm)	40	40	40	2	–
THICK PAPER 3 (211-256gsm)	40	40	40	2	–
OHP	–	–	–	–	40

FIG. 10

	PAPER TYPE NOT SPECIFIED	RECYCLED PAPER	COATED PAPER	ENVELOPE	OHP
THIN PAPER (52-59gsm)	0	0	–	–	–
PLAIN PAPER (60-81gsm)	2	0	–	–	–
MEDIUM THICK PAPER (82-105gsm)	2	0	–	–	–
THICK PAPER 1 (106-169gsm)	–	–	–	–	–
THICK PAPER 2 (167-210gsm)	–	–	–	–	–
THICK PAPER 3 (211-256gsm)	–	–	–	–	–
OHP	–	–	–	–	–

FIG. 11

	PAPER TYPE NOT SPECIFIED	RECYCLED PAPER	COATED PAPER	ENVELOPE	OHP
THIN PAPER (52-59gsm)	5	2	–	–	–
PLAIN PAPER (60-81gsm)	10	5	–	–	–
MEDIUM THICK PAPER (82-105gsm)	15	10	–	–	–
THICK PAPER 1 (106-169gsm)	–	–	–	–	–
THICK PAPER 2 (167-210gsm)	–	–	–	–	–
THICK PAPER 3 (211-256gsm)	–	–	–	–	–
OHP	–	–	–	–	–

FIXING DEVICE AND IMAGE FORMING APPARATUS INCORPORATING SAME

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. §119(a) to Japanese Patent Application No. 2013-168450, filed on Aug. 14, 2013, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

1. Technical Field

Embodiments of this disclosure generally relate to a fixing device and an image forming apparatus incorporating the fixing device, and more particularly, to a fixing device and an electrophotographic image forming apparatus, such as a copier, a printer, or a facsimile machine, incorporating the fixing device.

2. Description of the Related Art

Various types of electrophotographic image forming apparatuses are known, including copiers, printers, facsimile machines, or multifunction machines having two or more of the foregoing capabilities. In such image forming apparatuses, an electrostatic latent image is formed on a surface of a photoconductive drum serving as an image carrier. The electrostatic latent image thus formed is developed with toner serving as a developer into a visible toner image. The toner image is then transferred directly, or indirectly via a transfer belt onto a recording medium referred to as a sheet of paper, a recording sheet, a sheet, or a recording material with a transfer device so that the recording medium carries the toner image. Finally, the toner image is fixed onto the recording medium with a fixing device.

Such a fixing device typically includes a fixing member such as a roller, a belt, or a film, and a pressing member such as a roller or a belt. The pressing member is pressed against the fixing member to form a fixing nip therebetween. The toner image is fixed onto the recording medium under heat and pressure while the recording medium passes through the fixing nip.

SUMMARY

In one embodiment of this disclosure, an improved image forming apparatus is described that includes a rotatable fixing member, a pressing member, a plurality of heat generators, a plurality of temperature detectors, a power source, and a heat controller. The fixing member contacts an unfixed image. The pressing member is disposed opposite the fixing member to form a fixing nip between the pressing member and the fixing member. The plurality of heat generators are arrayed in a longitudinal direction perpendicular to a direction in which a recording medium is conveyed to heat respective heating areas of the fixing member. The plurality of temperature detectors are disposed to detect a surface temperature of the fixing member and temperatures of the plurality of heat generators. The power source supplies electric power to the plurality of heat generators to heat the respective heating areas. The heat controller controls the power source according to data provided by the temperature detectors, such that, when the unfixed image on the recording medium conveyed to the fixing nip contains an imaged area and a blank area, a temperature T**2** corresponding to the blank area is lower than a temperature T**1** corresponding to the imaged area. The plurality of heat generators include a first heat generator to heat a heating area of the fixing member corresponding to the imaged area and a plurality of second heat generators to heat heating areas corresponding to the blank area. The heat controller controls the power source such that a heating area of the fixing member heated by one of the plurality of second heat generators located adjacent to the first heat generator acquires a temperature of T**1**−ΔT, where ΔT is a temperature lower than a difference between the temperature T**1** and the temperature T**2**. The heat controller also changes ΔT between when a first side of the recording medium is printed upon duplex printing and upon single-sided printing.

Also described is an improved fixing device incorporated in the image forming apparatus. The fixing device includes a rotatable fixing member, a pressing member, and a plurality of heat generators. The fixing member contacts an unfixed image. The pressing member is disposed opposite the fixing member to form a fixing nip between the pressing member and the fixing member. The a plurality of heat generators are arrayed in a longitudinal direction perpendicular to a direction in which a recording medium is conveyed to heat respective heating areas of the fixing member such that, when the unfixed image on the recording medium conveyed to the fixing nip contains an imaged area and a blank area, a temperature T**2** corresponding to the blank area is lower than a temperature T**1** corresponding to the imaged area. The plurality of heat generators include a first heat generator to heat a heating area of the fixing member corresponding to the imaged area and a plurality of second heat generators to heat heating areas corresponding to the blank area. A heating area of the fixing member heated by one of the plurality of second heat generators located adjacent to the first heat generator acquires a temperature of T**1**−ΔT, where ΔT is a temperature lower than a difference between the temperature T**1** and the temperature T**2**. ΔT is different between when a first side of the recording medium is printed upon duplex printing and upon single-sided printing.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages thereof will be more readily obtained as the same becomes better understood by reference to the following detailed description of embodiments when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic view of an image forming apparatus according to an embodiment of this disclosure;

FIG. **2** is a schematic sectional view of a fixing device incorporated in the image forming apparatus of FIG. **1**;

FIG. **3** is a partial side view of the fixing device of FIG. **2**, illustrating a heater incorporated therein and heat generators of the heater;

FIG. **4**A is a plan view of a sheet, illustrating an image formation pattern including an imaged area, a blank area, and another imaged area, in that order, from a leading end of the sheet in a direction in which the sheet is conveyed;

FIG. **4**B is a plan view of a sheet, illustrating an image formation pattern including an imaged area and a blank area, in that order, from a leading end of the sheet in the direction in which the sheet is conveyed;

FIG. **5**A is a plan view of a sheet, illustrating an image formation pattern including an imaged area and a blank area in a longitudinal direction of a fixing roller with the heat generators illustrated in FIG. **3**;

FIG. **5**B is a plan view of a sheet, illustrating an image formation pattern including imaged areas and blank areas mixed in a width direction of the sheet and the direction in which the sheet is conveyed;

FIG. **6** is a graph of control temperatures of the heat generators to heat the sheet of FIG. **5**A according to a comparative example of selective heat control;

FIG. **7** is a graph of control temperatures of the heat generators to heat the sheet of FIG. **5**A according to a first example of selective heat control;

FIG. **8** is a graph of control temperatures of the heat generators to heat the sheet of FIG. **5**A according to a second example of selective heat control;

FIG. **9** is a parameter table of ΔT specified for single-side printing;

FIG. **10** is a parameter table of ΔT specified for a first side of the sheet upon duplex printing; and

FIG. **11** is a parameter table of ΔT specified for a second side of the sheet upon duplex printing.

The accompanying drawings are intended to depict embodiments of this disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have the same function, operate in a similar manner, and achieve similar results.

Although the embodiments are described with technical limitations with reference to the attached drawings, such description is not intended to limit the scope of the invention and all of the components or elements described in the embodiments of this disclosure are not necessarily indispensable to the present invention.

In a later-described comparative example, embodiment, and exemplary variation, for the sake of simplicity like reference numerals are given to identical or corresponding constituent elements such as parts and materials having the same functions, and redundant descriptions thereof are omitted unless otherwise required.

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, embodiments of this disclosure are described below.

Initially with reference to FIG. **1**, a description is given of a configuration and operation of an image forming apparatus **1** according to an embodiment of this disclosure.

FIG. **1** is a schematic view of the image forming apparatus **1**. The image forming apparatus **1** may be a copier, a facsimile machine, a printer, a multifunction peripheral or a multifunction printer (MFP) having at least one of copying, printing, scanning, facsimile, and plotter functions, or the like.

According to this embodiment, the image forming apparatus **1** is a tandem-type color printer. The image forming apparatus includes a bottle container **101** in an upper portion thereof. The bottle container **101** includes four toner bottles **102**Y, **102**M, **102**C, and **102**K, which are removable from the bottle container **101**. The toner bottles **102**Y, **102**M, **102**C, and **102**K contains toner of yellow, magenta, cyan, and black, respectively. It is to be noted that, in the following description, suffixes Y, M, C, and K denote colors yellow, magenta, cyan, and black, respectively.

An intermediate transfer unit **85** is disposed below the bottle container **101**. The intermediate transfer unit **85** includes an intermediate transfer belt **78**, four primary-transfer bias rollers **79**Y, **79**M, **79**C, and **79**K, a secondary-transfer backup roller **82**, a cleaning backup roller **83**, a tension roller **84**, and an intermediate transfer cleaner **80**. The intermediate transfer unit **85** includes four imaging stations **4**Y, **4**M, **4**C, and **4**K. Each of the imaging stations **4**Y, **4**M, **4**C, and **4**K faces the intermediate transfer belt **78**.

The imaging stations **4**Y, **4**M, **4**C, and **4**K includes photoconductive drums **5**Y, **5**M, **5**C, and **5**K, respectively. Each of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K is surrounded by various pieces of imaging equipment, such as a charging device **75**, a development device **76**, a cleaning device **77**, and a neutralizing device.

The photoconductive drums **5**Y, **5**M, **5**C, and **5**K are cylinders rotated by a drive source. In addition, each of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K has a photosensitive surface. An exposure device **3** is disposed below the imaging stations **4**Y, **4**M, **4**C, and **4**K. The exposure device **3** irradiates the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K with light beams indicated by broken lines in FIG. **1** to form electrostatic latent images thereon according to image data read by an image scanner or image data obtained from a terminal via a network.

The charging devices **75** uniformly charge the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K. The charging devices **75** of the present embodiment contact the photoconductive drums **5**Y, **5**M, **5**C, and **5**K to charge the surfaces thereof.

The development devices **76** supply toner for the respective photoconductive drums **5**Y, **5**M, **5**C, and **5**K. The toner thus supplied adheres to the electrostatic latent images formed on the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K. Thus, the development devices **76** renders the electrostatic latent images formed on the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K visible as toner images. The development devices **76** of the present embodiment attach toner to the electrostatic latent images without contacting the photoconductive drums **5**Y, **5**M, **5**C, and **5**K.

The cleaning devices **77** of the present embodiment contact the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K with brushes to remove residual toner therefrom.

The intermediate transfer belt **78** is an endless belt having a base layer of resin film or rubber, on which the toner images are transferred from the photoconductive drums **5**Y, **5**M, **5**C, and **5**K to be a color toner image. The intermediate transfer belt **78** is entrained around the secondary-transfer backup roller **82**, the cleaning backup roller **83**, and the tension roller **84**. The intermediate transfer belt **78** is rotated in a direction indicated by arrow X in FIG. **1** by rotation of the secondary-transfer backup roller **82**. The color toner image is then transferred from the intermediate transfer belt **78** onto a recording medium S as an unfixed toner image.

A series of imaging processes, namely, charging, exposure, developing, primary transfer, and cleaning processes are performed on each of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K. Accordingly, the toner images of yellow, magenta, cyan, and black are formed on the photoconductive drums **5**Y, **5**M, **5**C, and **5**K, respectively.

The primary-transfer bias rollers **79**Y, **79**M, **79**C, and **79**K and the photoconductive drums **5**Y, **5**M, **5**C, and **5**K sandwich the intermediate transfer belt **78** to form primary transfer nips, respectively. A transfer bias having a polarity opposite a polarity of the toner is applied to each of the primary-transfer bias rollers **79**Y, **79**M, **79**C, and **79**K.

Now, a detailed description is given of the series of imaging processes.

The photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated in a clockwise direction in FIG. **1** by a driving motor. In the charging process, the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are uniformly charged at a position opposite the respective charging devices **75**.

In the exposure process, the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated further and reach a position opposite the exposure device **3**, where the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are scanned with and exposed by light beams emitted from the exposure device **3** to form the electrostatic latent images of yellow, magenta, cyan, and black on the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K, respectively.

In the developing process, the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated further and reach a position opposite the respective development devices **76**, where the electrostatic latent images are developed with toner of yellow, magenta, cyan, and black into visible images, also known as toner images, of yellow, magenta, cyan, and black, respectively.

In the primary transfer process, the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated further and reach a position opposite the primary-transfer bias rollers **79**Y, **79**M, **79**C, and **79**K, respectively, via the intermediate transfer belt **78**, where the toner images are transferred from the photoconductive drums **5**Y, **5**M, **5**C, and **5**K onto the intermediate transfer belt **78**. The toner images formed on the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K through the developing process are transferred onto the intermediate transfer belt **78** while being superimposed one atop another to form a color toner image on the intermediate transfer belt **78**.

At this time, a small amount of toner may remain untransferred on the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K as residual toner. In the cleaning process, the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated further and reach a position opposite the respective cleaning devices **77**, where the cleaning devices **77** mechanically collect the residual toner on the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K with cleaning blades incorporated in the cleaning devices **77**, respectively.

Finally, the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are rotated and reach a position opposite the respective neutralizing devices, where residual potential is removed from the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K. Thus, the series of image forming processes performed on the surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K is completed.

Now, a detailed description is given of a series of transferring processes.

The intermediate transfer belt **78** travels in the direction indicated by arrow X and successively passes through the primary transfer nips formed between the primary-transfer bias rollers **79**Y, **79**M, **79**C, and **79**K, on the one hand, and the photoconductive drums **5**Y, **5**M, **5**C, and **5**K, respectively, on the other. Thus, the toner images formed on the respective surfaces of the photoconductive drums **5**Y, **5**M, **5**C, and **5**K are primarily transferred onto the intermediate transfer belt **78** while being superimposed one atop another to form a color toner image thereon.

Then, the intermediate transfer belt **78** carrying the color toner image reaches a position opposite the secondary transfer roller **89**, where the secondary-transfer backup roller **82** and the secondary transfer roller **89** sandwich the intermediate transfer belt **78** to form a secondary transfer nip. At the secondary transfer nip, the color toner image is transferred from the intermediate transfer belt **78** onto the recording medium S conveyed. At this time, a small amount of toner may remain untransferred on the intermediate transfer belt **78** as residual toner.

Then, the intermediate transfer belt **78** reaches a position opposite the intermediate transfer cleaner **80**, where the residual toner is collected from the intermediate transfer belt **78**. Thus, the series of transferring processes performed on the intermediate transfer belt **78** is completed.

Now, a detailed description is given of a series of image forming processes.

The recording medium S is fed from a paper tray **12** disposed in a lower portion of the image forming apparatus **1**, and conveyed to the secondary transfer nip via, e.g., a feed roller **97** and a pair of registration rollers **98**. The paper tray **12** accommodates a stack of recording media S, such as transfer sheets, one atop another. When the feed roller **97** is rotated in a counterclockwise direction in FIG. **1**, an uppermost recording medium S of the plurality of recording media S is fed toward an area of contact, herein called a roller nip, between the pair of registration rollers **98**.

The recording medium S conveyed to the pair of registration rollers **98** temporarily stops at the roller nip formed between the pair of registration rollers **98**, as the pair of registration rollers **98** stops rotating. The pair of registration rollers **98** is rotated again to convey the recording medium S to the secondary transfer nip in synchronization with the movement of the intermediate transfer belt **78** carrying the color toner image to transfer the color toner image onto the recording medium S at the secondary transfer nip.

Thereafter, the recording medium S carrying the color toner image is conveyed to a fixing device **20**. In the fixing device **20**, the color toner image is fixed onto the recording medium S under heat and pressure applied by a fixing roller **22** and a pressing roller **21**. Then, the recording medium S is conveyed to a toner cleaner **60** that removes unfixed toner from the recording medium S.

After the unfixed toner is removed, the recording medium S passes through a pair of discharge rollers **99**, and is discharged onto a discharge tray **100** outside the image forming apparatus **1**. Thus, the plurality of recording media S carrying output images rest one atop another on the discharge tray **100**. Accordingly, the series of image forming processes is completed.

The image forming apparatus **1** further includes a sheet reversing device **90**. The sheet reversing device **90** turns over the recording medium S to record images on both sides thereof and conveys the recording medium S to the pair of registration rollers **98** and further to the secondary transfer nip again.

The image forming apparatus **1** further includes a main controller and an operation input device. The main controller is a microcomputer including, e.g., a central processing unit (CPU), a read-only memory (ROM), a random-access memory (RAM), and an input/output (I/O) interface. The main controller executes programs that are preliminary stored in the ROM with the CPU.

The main controller is connected to, e.g., the operation input device, various sensors, motors and the like incorporated in the image forming apparatus **1**. According to detection signals received from the sensors, the main controller controls the motors such as the drive motor to rotate the photoconductive drums **5**Y, **5**M, **5**C, and **5**K, and a drive mechanism to rotate the pressing roller **21** while controlling a power supply for a heater incorporated in the fixing device **20**.

The operation input device is provided to the body of the image forming apparatus **1** and includes various keys, such as a numerical keypad and a print start key, and displays. The operation input device outputs signals inputted via the keys to the main controller.

Now, a detailed description is given of the toner cleaner **60**.

As described later, the fixing device **20** is controlled to selectively heat an imaged area. In such a fixing device, a faulty image generated by, e.g., toner drops outside an imaged area, may remain unfixed on the recording medium S. The toner cleaner **60** removes such unfixed toner from the recording medium S.

The toner cleaner **60** includes a brush roller **61** and an opposed roller **62**. The brush roller **61** physically scrapes the unfixed toner off the recording medium S. Alternatively, the toner cleaner **60** may remove unfixed toner by applying an electrostatic bias to a roller, by blowing air, by using an electrostatic brush that easily attracts toner, or the like.

Referring now to FIGS. **2** and **3**, a detailed description is given of the fixing device **20** incorporated in the image forming apparatus **1**.

FIG. **2** is a schematic sectional view of the fixing device **20** incorporated in the image forming apparatus **1** described above. FIG. **3** is a partial side view of the fixing device **20**, illustrating the heater **23** and the heat generators **23***a* through **23***g* of the heater **23**.

According to the present embodiment, the image forming apparatus **1** includes, e.g., a rotatable fixing member (e.g., fixing roller **22**), a pressing member (e.g., pressing roller **21**), a plurality of heat generators (e.g., heat generators **23***a* through **23***g*), a plurality of temperature detectors (e.g., thermistors **25** and **26**), a power source (e.g., power source **24**), and a heat controller (heat controller **27**). The fixing member contacts an unfixed image. The pressing member is disposed opposite the fixing member to form a fixing nip (e.g., fixing nip N) between the pressing member and the fixing member. The plurality of heat generators are arrayed in a longitudinal direction perpendicular to a direction in which a recording medium (e.g., sheet S) is conveyed to heat respective heating areas of the fixing member. The plurality of temperature detectors are disposed to detect a surface temperature of the fixing member and temperatures of the plurality of heat generators. The power source supplies electric power to the plurality of heat generators to heat the respective heating areas. The heat controller controls the power source according to data provided by the temperature detectors, such that, when the unfixed image on the recording medium conveyed to the fixing nip contains an imaged area and a blank area, a temperature T**2** corresponding to the blank area is lower than a temperature T**1** corresponding to the imaged area. In addition, the heat controller controls the power source such that, a heating area of the fixing member heated by, of the plurality of heat generators, a heat generator corresponding to the blank area located adjacent to a heat generator corresponding to the imaged area acquires a temperature of T**1**−ΔT, where ΔT is a temperature lower than a difference between the temperature T**1** and the temperature T**2**. The heat controller also changes ΔT between when a first side of the recording medium is printed upon duplex printing and upon single-sided printing.

Specifically, as illustrated in FIG. **2**, the fixing device **20** of the present embodiment employs an external heating system. The fixing device **20** includes the fixing roller **22** serving as a fixing member, the pressing roller **21** serving as a pressing member disposed opposite the fixing member to form a fixing nip N between the pressing member and the fixing member, and a heater **23**. In the present embodiment, the heater **23** is a thermal heater to heat the fixing roller **22**. As illustrated in FIG. **3**, the heater **23** is constructed of a plurality of heat generators, which, in the present embodiment, are seven heat generators **23***a* through **23***g*, arranged in a width direction of the sheet S, that is, a longitudinal direction of the fixing roller **22**. The heat generators **23***a* through **23***g* heat their respective heating areas indicated by dotted lines in FIG. **3**. The heat generators **23***a* through **23***g* can be controlled to individually heat their respective heating areas, and therefore, the temperature distribution of the fixing roller **22** can be controlled in the longitudinal direction thereof.

Referring back to FIG. **2**, the fixing device **20** further includes the power source **24** connected with the heater **23** to supply electric power for the heater **23**. Alternatively, the power source **24** and the heat controller **27** may be disposed outside the fixing device **20** in the image forming apparatus **1**.

The thermistor **25** is disposed downstream from the fixing nip N and upstream from the heater **23** in a direction indicated by arrow Y in which the fixing roller **22** rotates. The thermistor **25** serves as a temperature detector to detect a surface temperature of the fixing roller **22**. The thermistor **26** serves as a temperature detector to detect the temperature of the heater **23**, specifically, the plurality of heat generators **23***a* through **23***g*.

The heat controller **27**, which may be a part of the main controller or separate therefrom. The heat controller **27** is a microcomputer including, e.g., a CPU, a ROM, a RAM, and an I/O interface. The heat controller **27** executes programs that are preliminary stored in the ROM with the CPU to control the power source **24** to supply power for the plurality of heat generators **23***a* through **23***g* according to data provided by the thermistors **25** and **26**.

The fixing roller **22** is constructed of a metal core **22***a*, a heat insulation layer **22***b*, a heat conductive layer **22***c*, and a release layer **22***d*. The metal core **22***a* is made of aluminum, having an outer diameter of about 40 mm and a thickness of about 1 mm. The heat insulation layer **22***b* coats an outer surface of the metal core **22***a*. The heat insulation layer **22***b* is made of silicone rubber, having a thickness of about 3 mm. It is to be noted that the heat insulation layer **22***b* may be made of foam silicone rubber to prevent heat diffusion and enhance heat insulation.

The heat conductive layer **22***c* is made of nickel and provided on the heat insulation layer **22***b*. Alternatively, the heat conductive layer **22***c* may be made of another material as long as the heat conductive layer **22***c* has a higher heat conductivity than at least the heat insulation layer **22***b*. For example, the heat conductive layer **22***c* may be made of an iron alloy such as stainless steel, or metal such as aluminum or copper. Alternatively, the heat conductive layer **22***c* may be a graphite sheet.

The heat conductive layer **22***c* reduces localized unevenness in surface temperature of the fixing roller **22** caused by uneven heating by the heater **23**. Moreover, the heat conductive layer **22***c* increases the temperature of a slightly wider area than an area heated by the heater **23**, thereby compensating a slight shift from an image. Accordingly, sizes of and intervals between the heat generators **23***a* through **23***g* of the heater **23** can be determined relatively freely over a wide design range.

The release layer **22***d* is provided on the heat conductive layer **22***c* to enhance the durability and maintain the releasing performance of the fixing roller **22**. The release layer **22***d* is made of fluorine resin such as perfluoroalkoxy (PFA) or polytetrafluoroethylene (PTFE), having a thickness of about 5 μm to about 30 μm.

The pressing roller **21** is constructed of a metal core **21***a* and an elastic layer **21***b*. The metal core **21***a* is made of iron, having an outer diameter of about 40 mm and a thickness of about 2 mm. The elastic layer **21***b* coats an outer surface of the metal core **21***a*.

The elastic layer **21***b* is made of silicone rubber, having a thickness of about 5 mm. To enhance releasing performance, a fluorine resin layer having a thickness of about 40 μm may be provided on an outer surface of the elastic layer **21***b*.

It is to be noted that the pressing roller **21** is pressed against the fixing roller **22** by a biasing unit. The heater **23** is pressed against an outer surface of the fixing roller **22** by a biasing unit.

According to the present embodiment, the heater **23** contacts and heats the outer surface of the fixing roller **22**. Alternatively, the heater **23** may be an induction heater provided with an excitation coil and an inverter to inductively heat the fixing roller **22** without contacting the fixing roller **22**. The induction heater can control heating areas and heating amounts in a longitudinal direction with a configuration in which a plurality of heating coils are disposed or a plurality of members that cancel magnetic fluxes are disposed in the longitudinal direction.

For comparison, for energy efficiency, a comparative fixing device employs an external heating system to externally heat a roller as a fixing member to selectively heat an imaged area by setting a second temperature lower than a fixing temperature as a first temperature. Specifically, a fixing roller is heated from outside to fuse toner with heat accumulated around a surface of the fixing roller. Accordingly, warm-up time can be shorter and energy efficiency can be higher than with a fixing device employing an internal heating system to internally heat the entire fixing roller.

However, in the comparative fixing device, selectively heating an imaged area may cause a precipitous temperature difference in a longitudinal direction of the fixing member (i.e., temperature deviation in the longitudinal direction). Such a temperature difference may deform the fixing member and/or the pressing member facing the fixing member due to a thermal expansion difference and wrinkle the recording medium, causing conveyance errors and/or degrading image quality.

For example, the temperature of the fixing member may be controlled such that the fixing member has a higher temperature at the center in the longitudinal direction thereof (hereinafter simply referred to as center temperature) than a temperature at each end in the longitudinal direction thereof (hereinafter simply referred to as end temperature) to selectively heat the imaged area. In short, the fixing member has a larger thermal expansion at the center in the longitudinal direction thereof than a thermal expansion at each end in the longitudinal direction thereof. Particularly, in a fixing device such as the comparative fixing device that incorporates a drum-shaped fixing roller having a central portion of reduced diameter to prevent wrinkles in the recording medium, the fixing roller may be deformed and consequently lose the central portion of reduced diameter thereof. In other words, the fixing roller may have a center diameter equal to or larger than the end diameter due to thermal expansion if the fixing roller has a higher center temperature than the end temperature. In such a case, the fixing roller cannot sufficiently prevent wrinkles in the recording medium, increasing occurrence of wrinkles.

The recording medium may be wrinkled not only when the fixing member is heated at a higher center temperature than the end temperature, but also when the fixing member has a temperature deviation in the longitudinal direction thereof, for example, when only one side is heated. The recording medium may be wrinkled even if the fixing member is not a drum-shaped roller having a central portion of reduced diameter. For example, a cylindrical fixing roller may wrinkle the recording medium. In addition, the recording medium may be wrinkled not only in fixing devices employing a roller as a fixing member, but also in fixing devices employing a belt or a film as a fixing member. Moreover, the recording medium may be wrinkled in fixing devices employing a heating system other than the external heating system.

Upon duplex printing, generally, a first side of the recording medium passes through the fixing nip, and then a second side of the recording medium passes therethrough. The second side of the recording medium is more likely to be wrinkled than the first side of the recording medium.

By contrast, in the image forming apparatus **1** according to the embodiments of this disclosure, the fixing device **20** selectively heats an imaged area to prevent wrinkles in the recording medium.

Referring now to FIGS. **4**A through **11**, a description is given of selective heat control performed by the fixing device **20** of the image forming apparatus **1**. The image forming apparatus **1** enhances energy efficiency by controlling the heat generators **23***a* through **23***g* according to the image data.

FIG. **4**A is a plan view of a sheet S**1**, illustrating an image formation pattern including an imaged area A, a blank area B, and an imaged area A' in that order from a leading end of the sheet S**1** in a direction indicated by arrow Z (hereinafter referred to as sheet conveying direction Z) in which the sheet S**1** is conveyed. FIG. **4**B is a plan view of a sheet S**2**, illustrating an image formation pattern including an imaged area A and a blank area B in that order from a leading end of the sheet S**2** in the sheet conveying direction Z in which the sheet S**2** is conveyed.

When the sheet S**1** of FIG. **4**A passes through the fixing device **20**, the imaged areas A and A' are fixed while the blank area B is not fixed because the blank area B does not contain toner to be fixed on the sheet S**1**. On the other hand, when the sheet S**2** of FIG. **4**B passes through the fixing device **20**, only the imaged area A located in a leading portion of the sheet S**2** in the sheet conveying direction Z is fixed on the sheet S**2**.

For example, when the heat controller **27** receives image data of the image formation pattern illustrated in FIG. **4**A from the main controller, the heat controller **27** controls the temperature of the fixing roller **22** such that a portion of the fixing roller **22** corresponding to the blank area B acquires a lower temperature than portions of the fixing roller **22** corresponding to the imaged areas A and A'. It is to be noted that a portion of the fixing roller **22** corresponding to an imaged area or a blank area is a portion of the fixing roller **22** that adheres to the imaged area or the blank area. The heat controller **27** controls the power supply for the heat generators **23***a* through **23***g*, thereby controlling the temperature of the fixing roller **22**.

The portions of the fixing roller **22** corresponding to the imaged areas A and A' are heated to a fixing temperature T**1** of, e.g., about 140° C. that is sufficient to fix a solid image on the sheet S**1**. By contrast, the portion of the fixing roller **22** corresponding to the blank area B is heated to a temperature T**2** that is lower than the fixing temperature T**1**. A lower temperature T**2** further enhances energy efficiency. However, if the temperature T**2** is excessively low, it may take time to heat the fixing roller **22** to the fixing temperature T**1** to fix a subsequent imaged area (e.g., the imaged area A' illustrated in FIG. **4**A). Accordingly, the temperature T**2** is preferably about 80° C. or higher. According to the present embodiment, the fixing temperature T**1** is about 140° C., and the temperature T**2** is about 100° C.

In FIGS. **4**A and **4**B, the electric power is supplied throughout the heater **23** so that the portions of the fixing roller **22** corresponding to the imaged areas A and A' acquire the fixing temperature T**1**, whereas the power supply for the heater **23** is reduced to heat the portion of the fixing roller **22** corresponding to the blank area B. It is to be noted that the power supply for the heater **23** is started to heat a portion of the fixing roller **22** corresponding to a preliminary heating area W, which is illustrated with hatching in each of FIGS. **4**A and **4**B, before heating the portion of the fixing roller **22** corresponding to the imaged areas A and A' that enters the fixing nip N. The preliminary heating area W is provided taking into account a heat generating length of the heater **23** in a circumferential direction thereof and the time taken to warm up the heater **23**. Preferably, the preliminary heating area W is as small as possible for enhanced energy efficiency.

FIG. **5**A is a plan view of a sheet S**3**, illustrating an image formation pattern including an imaged area C and a blank area D in a longitudinal direction of the fixing roller **22**, that is a width direction of the sheet S**3**, with the heat generators **23***a* through **23***g*. In this example, the heat generators **23***b*, **23***c*, and **23***d* are located corresponding to the imaged area C while the heat generators **23***e* and **23***f* are located corresponding to the blank area D.

FIG. **5**B is a plan view of a sheet S**4**, illustrating an image formation pattern including imaged areas A and C and blank areas B and D mixed in the width direction of the sheet S**4** and the sheet conveying direction Z. In such a case, later-described control may be performed defining that the common area of the blank areas B and D is a blank area, and that the area except for the blank area of the sheet S**4** is an imaged area.

FIG. **6** is a graph of control or target temperatures of the heat generators **23***b* through **23***f* when a plurality of sheets P**3** having the same image formation pattern illustrated in FIG. **5**A are supplied and heated according to a comparative example of selective heat control. In FIG. **6**, P represents a time width in which the sheet S**3** passes through the fixing nip N while P' represents a time interval between the sheets S**3** passing through the fixing nip N.

The electric power is supplied for the heat generators **23***b* through **23***d* located corresponding to the imaged area C so that the heat generators **23***b* through **23***d* reach the temperature T**1** as a target fixing temperature during P.

Then, the power supply is controlled to decrease the temperatures of the heat generators **23***b* through **23***d* down to the temperature T**2**, which is a temperature corresponding to a blank area, as a target temperature during P' because there is no image between the sheet S**3**.

The temperature T**2** lower than the fixing temperature T**1** contributes to reduction in energy consumption.

In the meantime, the power supply is controlled such that the heat generators **23***e* and **23***f* heat a portion of the fixing roller **22** corresponding to the blank area D at the temperature T**2**, regardless of P or P', because the blank area D does not contain toner to be fixed onto the sheet S**3**. It is to be noted that, in this example of FIG. **5**A, heat control is not performed on the heat generators **23***a* and **23***g* because their heating areas are outside the width of the sheet S**3**.

In the comparative example of selective heat control, the power supply is controlled such that a portion of the fixing roller **22** heated by the heat generator **23***d* corresponding to the imaged area C acquires the temperature T**1** while a portion of the fixing roller **22** heated by the heat generator **23***e* corresponding to the blank area D acquires the temperature T**2**, as illustrated in FIG. **6**. In short, the fixing roller **22** is not uniformly heated in the longitudinal direction thereof. Such a temperature difference between adjacent heat generators, namely, the heat generators **23***d* and **23***e* may be a precipitous temperature difference in the longitudinal direction of the fixing roller **22** that causes a thermal expansion difference. As a result, the drum-shaped fixing roller **22** is deformed, losing its central portion of reduced diameter. Such deformed fixing roller **22** may wrinkle the sheet S**3**.

Hence, in the image forming apparatus **1** of the present embodiment, the heat controller **27** controls the power source **24** such that, a heating area of the fixing roller **22** heated by, of heat generators corresponding to a blank area, a heat generator located adjacent to a heat generator corresponding to an imaged area acquires a temperature of T**1**−ΔT, where ΔT is a target heating temperature difference lower than a difference between the fixing temperature T**1** and the temperature T**2**.

FIG. **7** is a graph of control temperatures of the heat generators **23***b* through **23***f* when the plurality of sheets P**3** having the same image formation pattern illustrated in FIG. **5**A are supplied and heated in the fixing device **20** of the present embodiment, according to a first example of selective heating control.

In the example of FIG. **7**, the temperatures of the heat generators **23***b* through **23***d* are controlled to heat their respective heating areas corresponding to the imaged area C at the temperature T**1** as a target fixing temperature during P, whereas the temperatures of the heat generators **23***b* through **23***d* are decreased to the temperature T**2** as a target temperature during P'. Similar to the comparative example, heat control is not performed on the heat generators **23***a* and **23***g* because their respective heating areas are outside the width of the sheet S**3**.

In addition, the temperature of the heat generator **23***e* is controlled to be the temperature of T**1**−ΔT, which is a temperature obtained by subtracting the target heating temperature difference ΔT from the fixing temperature T**1**, as a target temperature during P, whereas the temperature of the heat generator **23***e* are decreased to the temperature T**2** as a target temperature during P'. It is to be noted that, of the heat generators having their respective heating areas corresponding to the blank area D, the heat generator **23***e* is located closest to the heat generator **23***d* having its heating area corresponding to the imaged area C.

The target heating temperature difference ΔT of the present embodiment is any value lower than the difference between the fixing temperature T**1** and the temperature T**2**. A larger target heating temperature difference ΔT contributes to a higher energy efficiency whereas it generates a larger temperature difference between the heat generators **23***d* and **23***e*. A target heating temperature difference ΔT closer to the difference between the fixing temperature T**1** and the temperature T**2** more likely to wrinkle the sheet S**3** as in the comparative example of selective heating control. For this reason, preferably, the target heating temperature difference ΔT is sufficiently lower than the difference between the fixing temperature T**1** and the temperature T**2**.

According to the present embodiment, heating areas of a fixing member (e.g., fixing roller **22**) heated by two adjacent heat generators, one of which corresponds to an imaged area (e.g., heat generator **23***d*) and the other corresponds to a blank area (e.g., heat generator **23***e*), acquire the target heating temperature difference ΔT that is lower than the difference between the fixing temperature T**1** and the temperature T**2**. Accordingly, the fixing roller **22** is prevented from losing its central portion of reduced diameter and wrinkles in a recording medium (e.g., sheet S**3**) is further prevented.

In addition, heating areas of the fixing member heated by adjacent heat generators corresponding to the blank area preferably acquire the target heating temperature difference ΔT therebetween in a phased manner starting from the heat generator **23**e. In other words, according to the present embodiment, the power supply is controlled such that the heating areas of the fixing member heated by the adjacent heat generators corresponding to the blank area acquire the target heating temperature difference ΔT in a phased manner starting from one of the adjacent heat generators corresponding to the blank area located adjacent to a heat generator corresponding to the imaged area. In the example of FIG. **5**A, the heating areas of the fixing member heated by the heat generators **23**e and **23**f acquire the target heating temperature difference ΔT.

However, if ΔT is sufficiently large, in this case, if a relation of $(T1-T2)/2<\Delta T$ is satisfied, the temperature of the heat generator **23**f is not higher than the temperature T**2**. Preferably, the temperature of the heat generator **23**f is higher than the temperature T**2** for a quick warm up of the heater **23**. Hence, the power supply is preferably controlled such that the heating area of the fixing member heated by the heat generator **23**f acquires a higher temperature of the temperature T**2** and a temperature of $T1-2\cdot\Delta T$, which is a ΔT lower than the target temperature of $T1-\Delta T$ of the heat generator **23**e.

In the example of FIG. **7**, the temperature of $T1-2\cdot\Delta T$ is lower than the temperature T**2**. Accordingly, the temperature of the heat generator **23**f is controlled to be the temperature T**2** as a target temperature.

By contrast, the target heating temperature difference ΔT is relatively small in an example of FIG. **8**. FIG. **8** is a graph of control temperatures of the heat generators **23**b through **23**f when the plurality of sheets P**3** having the same image formation pattern illustrated in FIG. **5**A are supplied and heated in the fixing device **20** of the present embodiment, according to a second example of selective heating control.

In the example of FIG. **8**, the temperature of $T1-2\cdot\Delta T$ is higher than the temperature T**2**. Accordingly, the temperature of the heat generator **23**f is controlled to be the temperature of $T1-2\cdot\Delta T$ as a target temperature.

Since a smaller temperature difference ΔT reduces energy efficiency while having a larger effect of preventing wrinkles in the sheet S**3**, an optimum temperature difference ΔT is specified depending on conditions. For example, a thinner sheet S**3** is more easily wrinkled. Accordingly, a relatively small temperature difference ΔT is specified as in the second example illustrated in FIG. **8**. By contrast, a thicker sheet S**3** is less easily wrinkled. Accordingly, a relatively large temperature difference ΔT is specified to reduce energy consumption.

According to the present embodiment, two heat generators are used to heat the blank area and the power supply for the two heat generators are controlled as described above. Alternatively, three or more heat generators may be used to heat the blank area and the power supply for the three or more heat generators may be similarly controlled. In other words, it is determined whether a control temperature is not lower than the temperature T**2**. If a relation of $T1-n\cdot\Delta T>T2$ is satisfied, the power supply is controlled such that a heating area of the fixing member heated by an n-th heat generator of the heat generators corresponding to the blank area acquires a temperature of $T1-n\cdot\Delta T$, where "n" represents an order of the heat generators corresponding to the blank area starting from 1 with the one of the heat generators corresponding to the blank area located adjacent to the heat generator corresponding to the imaged area. If a relation of $T1-n\cdot\Delta T<T2$ is satisfied, the power supply is controlled such that the heating area of the fixing member heated by the n-th heat generator acquires the temperature T**2**.

Upon duplex printing, the first side of the sheet S passes through the fixing device **20**, and then a second side of the sheet S passes therethrough. Particularly, a sheet S that is not uniformly heated in a longitudinal direction thereof (e.g., sheet S**3**) is most likely to be wrinkled when the sheet S passes through the fixing device **20** again. In short, upon duplex printing, the sheet S is more likely to be wrinkled when the second side thereof passes through the fixing device **20** than when the first side thereof passes through the fixing device **20**.

Hence, in the image forming apparatus **1** of the present embodiment, the heat controller **27** changes ΔT between when the first side of the sheet S is printed upon duplex printing and upon single-sided printing. ΔT is also changed between when the first side of the sheet S is printed upon duplex printing and when the second side of the sheet S is printed upon duplex printing. According to the present embodiment, ΔT may be the same or different between when the second side of the sheet S is printed upon duplex printing and upon single-sided printing.

For example, a smaller ΔT is specified for the first side of the sheet S passing through the fixing device **20** upon duplex printing than a ΔT specified for single-sided printing. The smaller ΔT eliminates an uneven heating of the sheet S in the longitudinal direction thereof and prevents wrinkles on the second side of the sheet S upon duplex printing. In such a case, a relation of $\Delta T=0$ may be satisfied when the first side of the sheet S is printed. In other words, selective heat control may not be performed when the first side of the sheet S is printed whereas the selective heat control may be performed only when the second side of the sheet S is printed.

As described above, in an image forming apparatus (e.g., image forming apparatus **1** according to the present embodiment, a fixing device (e.g., fixing device **20**) selectively heats an imaged area by specifying a fixing temperature (e.g., fixing temperature T**1**) corresponding to the imaged area and a temperature (e.g., temperature T**2**) corresponding to a blank area. A heat controller (e.g., heat controller **27**) controls a power source (e.g., power source **24**) that supplies electric power for heat generators (e.g., heat generators **23**a through **23**g) such that a target temperature difference between adjacent heat generators is lower than a temperature difference between the fixing temperature T**1** and the temperature T**2**. In addition, the target temperature difference between the adjacent heat generators is controlled to be not larger than a predetermined temperature to prevent a precipitous temperature difference in a longitudinal direction of a fixing member (e.g., fixing roller **22**).

Accordingly, the fixing member and a pressing member (e.g., pressing roller **21**) disposed opposite the fixing member are not deformed due to thermal expansion difference, thereby preventing wrinkles in a recording medium (e.g., sheet S). Particularly, when the fixing member is a drum-shaped fixing roller having a central portion of reduced diameter, the shape of the fixing roller is maintained to prevent wrinkles in the recording medium.

Wrinkles in the recording medium is noticeable when the recording medium is unevenly heated or unevenly absorbs moisture in a longitudinal direction thereof. Accordingly, upon duplex printing, the second side of the sheet S may be wrinkled after the first side thereof is heated. To prevent such wrinkles on the second side of the sheet S, a smaller target heating temperature difference ΔT is specified for the first side of the sheet S upon duplex printing so that heat control is performed in a manner similar to an uniform heat control.

Preferably, the target heating temperature difference ΔT is changed according to the thickness of the recording medium. Generally, thinner sheets are more easily wrinkled whereas thicker sheets are less easily wrinkled even if the drum-shaped fixing roller is deformed and loses its central portion of reduced diameter. Accordingly, a smaller ΔT is specified for a thinner sheet whereas a larger ΔT is specified for a thicker sheet. The above-described control may not be performed when a recording medium having a certain thickness (e.g., 105 gsm or larger) is used because such recording medium are not wrinkled. In such a case, heat control is performed as in the comparative example of selective heat control.

Accordingly, wrinkles in the recording medium can be effectively prevented and power consumption can be reduced.

In addition, the target heating temperature difference ΔT is preferably changed according to the type of the recording medium. Generally, tough sheets are hardly wrinkled, such as overhead projector (OHP) sheets and coated sheets. Accordingly, a larger target heating temperature difference ΔT is specified for the OHP sheets and coated sheets than a target heating temperature difference ΔT specified for plain sheets. By contrast, a smaller target heating temperature difference ΔT is specified for sheets easily wrinkled, such as envelopes, than the target heating temperature difference ΔT specified for plain sheets.

Accordingly, wrinkles in the recording medium can be effectively prevented and power consumption can be reduced.

Preferably, the above-described target heating temperature difference ΔT is obtained by e.g., experiments beforehand for each occasion, that is, upon single-sided printing, when the first side of the recording medium is printed upon duplex printing, and when the second side of the recording medium is printed upon duplex printing. In addition, the target heating temperature difference ΔT is preferably obtained beforehand for each type or thickness of the recording medium or a combination of the type and thickness of the recording medium.

It is to be noted that the target heating temperature difference ΔT is stored in a memory of the heat controller **27** as a parameter table.

Referring now to FIGS. **9** through **11**, a description is given of the parameter table.

FIG. **9** is a parameter table of ΔT specified for single-sided printing. FIG. **10** is a parameter table of ΔT specified for the first side of the sheet S upon duplex printing. FIG. **11** is a parameter table of ΔT specified for the second side of the sheet S upon duplex printing.

A target heating temperature difference ΔT is read out corresponding to, e.g., a printing type (e.g., duplex printing), paper thickness and/or paper type designated via an input device such as an operation panel for printing. A power supply for the heat generators is controlled according to the target heating temperature difference ΔT.

It is to be noted that, when a recording medium having a certain thickness is used, heat control is performed in the same manner as the comparative example of selective heat control because such a recording medium are not wrinkled, by satisfying a relation of ΔT=T**1**−T**2** for an endmost heat generator corresponding to the blank area.

It is to be noted that the number of constituent elements and their locations, shapes, and so forth are not limited to any of the structure for performing the methodology illustrated in the drawings.

For example, the above-described fixing device **20** employs a roller-type fixing system. Alternatively, however, the fixing device **20** may employ a belt-type or film-type fixing system. The pressing member may be, e.g., a belt instead of a roller. In addition, the heater is not limited to the above-described example as long as the heater has a plurality of heating areas in the longitudinal direction of the fixing member that can be individually controlled.

This disclosure has been described above with reference to specific embodiments. It is to be noted that this disclosure is not limited to the details of the embodiments described above, but various modifications and enhancements are possible without departing from the scope of the invention. It is therefore to be understood that this disclosure may be practiced otherwise than as specifically described herein. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present invention.

What is claimed is:

1. An image forming apparatus comprising:

a rotatable fixing member to contact an unfixed image;

a pressing member disposed opposite the fixing member to form a fixing nip between the pressing member and the fixing member;

a plurality of heat generators arrayed in a longitudinal direction perpendicular to a direction in which a recording medium is conveyed to heat respective heating areas of the fixing member;

a plurality of temperature detectors disposed to detect a surface temperature of the fixing member and temperatures of the plurality of heat generators;

a power source to supply electric power to the plurality of heat generators to heat the respective heating areas; and

a heat controller to control the power source according to data provided by the temperature detectors, such that, when the unfixed image on the recording medium conveyed to the fixing nip contains an imaged area and a blank area, a temperature T**2** corresponding to the blank area is lower than a temperature T**1** corresponding to the imaged area,

wherein the plurality of heat generators include a first heat generator to heat a heating area of the fixing member corresponding to the imaged area and a plurality of second heat generators to heat heating areas of the fixing member corresponding to the blank area,

wherein the heat controller controls the power source such that one of the plurality of second heat generators located adjacent to the first heat generator is set to a temperature of T**1**−ΔT, where ΔT is a temperature lower than a difference between the temperature T**1** and the temperature T**2**, when the unfixed image on the recording medium conveyed to the fixing nip contains the imaged area and the blank area, and

wherein the heat controller changes ΔT between when a first side of the recording medium is printed upon duplex printing and upon single-sided printing.

2. The image forming apparatus according to claim **1**, wherein the heat controller changes ΔT between when the first side of the recording medium is printed upon the duplex printing and when a second side of the recording medium is printed upon the duplex printing.

3. The image forming apparatus according to claim **1**, wherein the heat controller sets ΔT to zero when the first side of the recording medium is printed upon the duplex printing.

4. The image forming apparatus according to claim **1**, wherein the heat controller controls the power source such that heating areas of the fixing member heated by adjacent heat generators of the plurality of second heat generators acquire a temperature difference of ΔT therebetween in a phased manner starting from the one of the plurality of second heat generators located adjacent to the first heat generator, and wherein the heat controller determines whether a control temperature is not lower than the temperature T2, and controls the power source such that, if a relation of $T1-n\cdot\Delta T>T2$ is satisfied, a heating area of the fixing member heated by an n-th heat generator of the plurality of second heat generators acquires a temperature of $T1-n\cdot\Delta T$, where "n" represents an order of the plurality of second heat generators starting from 1 with the one of the plurality of second heat generators located adjacent to the first heat generator, and if a relation of $T1-n\cdot\Delta T<T2$ is satisfied, the heating area of the fixing member heated by the n-th heat generator acquires the temperature T2.

5. The image forming apparatus according to claim **1**, wherein the heat controller changes ΔT according to a thickness of the recording medium.

6. The image forming apparatus according to claim **1**, wherein the heat controller changes ΔT according to a type of the recording medium.

7. A fixing device comprising:

a rotatable fixing member to contact an unfixed image;

a pressing member disposed opposite the fixing member to form a fixing nip between the pressing member and the fixing member; and

a plurality of heat generators arrayed in a longitudinal direction perpendicular to a direction in which a recording medium is conveyed to heat respective heating areas of the fixing member such that, when the unfixed image on the recording medium conveyed to the fixing nip contains an imaged area and a blank area, a temperature T2 corresponding to the blank area is lower than a temperature T1 corresponding to the imaged area,

wherein the plurality of heat generators include a first heat generator to heat a heating area of the fixing member corresponding to the imaged area and a plurality of second heat generators to heat heating areas of the fixing member corresponding to the blank area,

wherein one of the plurality of second heat generators located adjacent to the first heat generator is set to a temperature of $T1-\Delta T$, where ΔT is a temperature lower than a difference between the temperature T1 and the temperature T2, when the unfixed image on the recording medium conveyed to the fixing nip contains the imaged area and the blank area, and

wherein ΔT is different between when a first side of the recording medium is printed upon duplex printing and upon single-sided printing.

8. The fixing device according to claim **7**, wherein ΔT is different between when the first side of the recording medium is printed upon the duplex printing and when a second side of the recording medium is printed upon the duplex printing.

9. The fixing device according to claim **7**, wherein ΔT is zero when the first side of the recording medium is printed upon the duplex printing.

10. The fixing device according to claim **7**, wherein ΔT depends on a thickness of the recording medium.

11. The fixing device according to claim **7**, wherein ΔT depends on a type of the recording medium.

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